Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 6, 2021, Pages. 7263 - 7272
Received 25 April 2021; Accepted 08 May 2021.

Phytochemical Screening of *Artocarpusaltilis* (Parkinson) Fosberg Unripe Fruit Extracts

[1]Meera Sabari V,[2]Beena Lawrence,[1]T. Citarasu

[1]Department of Marine Biotechnology, Centre for Marine Science and Technology, Rajakkamangalam, ManonmaniamSundaranar University, Kanyakumari District.

[2] Department of Botany, Women's' Christian College, Nagercoil, *Affiliated to* ManonmaniamSundaranar University, Abishekapetti, Tirunelveli.

e-mail- neelmeera26@gmail.com

*C*ontact number- +91 9786302081

Abstract

***Artocarpusaltilis*(Parkinson) Fosberg**commonly known as breadfruit belonging to *Moraceae* family is a monoecious tree widely grown in the hot, moist regions throughout southeast Asia, South India and most Pacific Ocean islands.Breadfruit has a wide range of application in traditional medicine andis primarily used as a food source. *Artocarpus* extracts and metabolites from leaves, stem, fruit, and bark contain numerous beneficial biologically active compounds and these compounds are used for various biological activities including antibacterial, antiviral, antifungal, antitubercularetc.In the present study five different cold percolation extracts of *Artocarpusaltilis*unripe fruit *viz*: aqueous, methanol, ethyl acetate, hexane, and acetone were screened individually to test the presence of various phytochemicals using standard procedures.Methanol extract showed the presence of nineteen phytochemical constituents followed by water, acetone, hexane and ethyl acetate.

Key words :*Artocarpusaltilis*, solvents, cold percolation, phytochemicals.

1. Introduction

Artocarpusaltilis is one of the highest food yielding plants, with a single tree producing upto 200 or more grape fruit-sized fruits from March to June and from July to September (Akanbi*et al*., 2009) per season and require limited care.As it is similar to freshly baked bread it is commonly called as

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 6, 2021, Pages. 7263 - 7272
Received 25 April 2021; Accepted 08 May 2021.

breadfruit. Breadfruit includes hundreds of varieties and thousands of common names which vary according to its geographic distribution, and is cultivated in over 90 countries (Morton and Julia,1987).Breadfruit is also known as a traditional starch rich crop. Synonyms of *Artocarpusaltilis* are *Artocarpuscommunis* and *Artocarpus incises* (Orwaet*et al*., 2014). Breadfruit grows in coral sands and saline soils.Over 130 compounds are identified in various organs of the tree of *Artocarpusaltilis,* morethan 70 of which derived from the phenylpropanoid pathway.The fruits contain artocarpine and the enzyme papayotine. The leaves contain the phenols, quercetin andcamphorol, plus gamma-aminobutyric acid, which lowers blood pressure.The roasted flowers are rubbed on the gums around aching teeth to ease pain. Latexfrom this plant is bandaged on the spine to relieve sciatica. Diluted latex is also taken internally to treat diarrhea, stomach ache and dysentery.The mature yellow leaves have a capacity to reduce blood pressure levels and to control diabetes when brewed with tea.The root extract is an astringent and is also used as a purgative.Bark extracts had proven to possess strong cytotoxic activities against leukemia cells in tissue culture.Several studies had emphasized the antioxidant and antimicrobial potentiality of *Artocarpusaltilis* along with its therapeutic properties as well as its effect on angiotensin-converting enzyme (ACE) activity.The ability of breadfruit pulp extract to inhibit cervical cancer cell proliferation was also demonstrated.The present study would emphasize the phytochemical strength of breadfruit.

2.Materials and Methods

2.1 Collection and processing of plant material

Mature unripe seedless fresh fruits of *A. altilis* (Parkinson) Fosberg were collected from Kanyakumari district, Tamil Nadu and brought to the laboratory, washed thoroughly, air dried in shade and reduced to coarse powder in a mixer grinder. The plant was authenticated by Dr. S. Mutheeshwaran, Entomology Research Institute, Loyola College, Chennai, Tamil Nadu, India.

2.2 Preparation of unripefruit extracts of *A. altilis* (Parkinson) Fosberg

Mature unripe seedless fresh fruits of *A. altilis* (Parkinson) Fosbergweresequentially extracted with different organic solvents such as hexane, ethyl acetate, acetone, methanol and water in increasing polarity (Starmans & Nijhuis,1996). The crude extracts obtained were evaporated under reduced pressure at 40^{o}C and finally concentrated and stored in a refrigerator at 2-8^{o}Cfor use in subsequent experiments

2.3Phytochemical analysis of unripefruit extracts of *A. altilis* (Parkinson) Fosberg

The solvent extracts of *Artocarpusaltilis*fruits were subjected to phytochemical studies to screen the presence of phytoconstituents such as carbohydrates, quinones, alkaloids, aminoacids, proteins, reducing sugars, flavonoids, gums and mucilages, tannins, resins,

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 6, 2021, Pages. 7263 - 7272
Received 25 April 2021; Accepted 08 May 2021.

terpenoids, phenols, saponins, cardiac glycosides, volatile oils, starch, betacyanins, coumarins, steroids, anthraquinone, phlobatannins, emodols and fattyacids .

2.3.1 Molisch's test for carbohydrates (Sofowora, 1993)

The extracts were treated with 2 drops of alcoholic alpha-napthol solution in a test tube and 2 ml concentrated H_2SO_4 was added carefully along the sides of the test tubes. Formation of red ring at the interphase indicated the presence of carbohydrates.

2.3.2 Test for quinones (Evans, 1996)

To 1 ml of each solvent extract 1 ml of concentrated H_2SO_4 was added . Formation of red colour would indicate the presence of quinones .

2.3.3 Test for alkaloids (Evans, 1997)

The extracts were treated with Mayer's reagent (1.36 gm mercuric chloride and 5 gm of potassium iodide was dissolved in 100 ml distilled water). The formation of yellow cream predicted the presence of alkaloids.

2.3.4 Ninhydrin test for aminoacids(Yasuma and Ichikawa, 2000)

To each of the solvent extract 0.25% ninhydrin reagent was added and boiled for few minutes for the development of blue colour .

2.3.5 Test for proteins

The extracts were treated with 1 ml of 10% NaOH solution and heated . To this extract a drop of 0.7% $CuSO_4$ solution was added. Formation of purplish violet colour was observed.

2.3.6 Benedict's test for reducing sugars (Tiwari *et al.,* 2011)

The extracts were treated with Benedict's reagent and heated on a water bath. Orange red coloured precipitate was formed.

2.3.7 Ferric chloride test for flavonoids (Raman, 2006)

The extracts were treated with few drops of $FeCl_3$ solution . Formation of a blackish red

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 6, 2021, Pages. 7263 - 7272
Received 25 April 2021; Accepted 08 May 2021.

colour indicated the presence of flavonoids .

2.3.8 Test for gum and mucilages (Whistler and Bemiller, 1993)

About 5 ml of all the extract was slowly added to 5 ml of absolute alcohol under constant stirring.The test was performed individually for all the extracts individually. Presence of gum and mucilages were identified through the occurrence of precipitates.

2.3.9 Test for tannins(Trease and Evans, 1989)

To 1 ml of each of the solvent extract, a few drops of $FeCl_3$ solution was added. The appearance of black and a green precipitate indicated the presence of tannins.

2.3.10 Acetone – water test for resins

The extracts were treated with acetone followed by a small amount of water and shaken well. Appearance of turbidity indicated the presence of resins .

2.3.11 Test for terpenoids (Evans, 1997)

To 1 ml of each of the solvent extract, 2 ml of chloroform was added. Then 3 ml of concentrated H_2SO_4 was carefully added to form a layer. A reddish brown coloration of the interface showed the presence of terpenoids.

2.3.12 Ferric chloride test for phenols(Mace, 1963)

To 1 ml of solvent extract 3 ml of distilled water was added. To this, a few drops of neutral 5% $FeCl_3$ solution was added. Presence of phenols were confirmed through the formation of a dark green colour.

2.3.13 Foam test for saponins (Kumar *et al.,* 2009)

About 2 ml of distilled water and 1 ml of each solvent extract were mixed and shaken vigorously. Formation of a stable persistent froth indicated the presence of saponins.

2.3.14 Keller – killani test for cardiac glycosides(Sofowora, 1984)

The extract was dissolved in glacial acetic acid containing traces of $FeCl_3$. The tube was then held at an angle of 45^{o} C and 1 ml of concentrated H_2SO_4 was added along the

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 6, 2021, Pages. 7263 - 7272
Received 25 April 2021; Accepted 08 May 2021.

sides of the tubes. Formation of a purple ring at the interphase indicated the presence of cardiac glycosides.

2.3.15 Test for volatile oils(Trease and Evans, 1989)

To 1 ml of each extract, 1 ml of 90% ethanol was added followed by the addition of few drops of $FeCl_3$ solution . Formation of green colour would indicate the presence of volatile oils .

2.3.16 Test for starch

The plant extracts (5 ml) were treated with few drops of iodine reagent to get a blue violet colour. Apperence of the same revealed the presence of starch.

2.3.17 Test for betacyanins(Harbone, 1973)

With 2 ml of each of the plant extract, 1 ml of 2N NaOH was added and heated for 5 minutes in water bath. Formation of yellow color indicated the presence of betacyanin .

2.3.18 Test for coumarins

About 3 ml of 10% Sodium hydroxide (NaOH) solution was added to 2 ml of plant extracts individually. Formation of yellow color indicated the presence of coumarins.

2.3.19 Test for steroids (Kokate, 1994)

Plant extracts (1ml) were dissolved in 10 ml of chloroform and then equal volume of concentrated sulphuric acid was added from the side of test tubes. red Upper layer turned red andsulphuric acid layer showed yellow with green fluorescence. This result suggested the presence of steroids.

2.3.20 Test for anthraquinones(Sofowora, 1993)

Plant extracts (0.5 ml) were boiled with 10% HCl for few minutes on water bath. The reaction mixture was filtered and allowed to cool. Equal volume of chloroform was added to each filtrate and few drops of 10% ammonia was added and then heated. Formation of rose to pink color was observed.

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 6, 2021, Pages. 7263 - 7272
Received 25 April 2021; Accepted 08 May 2021.

2.3.21 Test for phlobatannins(Harbone, 1973)

2 ml of all the plant extracts were boiled individually with 1 ml of 1% aqueous hydrochloric acid. The formation of red precipitate indicated the presence of phlobatannins.

2.3.22 Test for emodols

With 2 ml of plant extracts, 2 ml of ammonium hydroxide (NH_4OH) and 3 ml of benzene was added. Appearance of red color indicated the presence of emodins.

2.3.23 Test for fatty acids(Ayoola*et al.*, 2008)

About 2ml of extract was treated with few drops of Sudan III reagents . The appearance of dark red oil droplet in the upper layer indicated the presence of fatty acids.

3. **RESULTS AND DISCUSSION**

Plants used in traditional medicine contain a lot of bioactive materials which play a major role in treating infectious diseases. (Balakumar*et al*., 2011; Florence *et al*., 2012; Joselin *etal*., 2012; Rajan*et al*., 2011).Natural biologically active compounds of plants are classified in to major groups such as sterols, triterpenes, flavones, emodols, coumarins, tannins, reducing compounds, glycosides, saponins, sapogenins etc. All these substances contribute to the medicinal properties of plants.Basically *Artocarpus* species consists of phenolic compounds, flavonoids, jacalin, lectin and stilbenoids . *Artocarpus* extracts and metabolites from leaves, stem, fruit and bark contain numerous beneficial biologically active compounds and these compounds are used for various biological activities including antibacterial, antitubercular, antiviral, antifungal, antiplatelet, antiarthritic, tyrosinase inhibitory and cytotoxicity (Jagtap&Bapat, 2010).Among the 23 phytochemicals tested using five different cold percolation extracts of *Artocarpusaltilis* unripe fruit, carbohydrates, quinones, terpenoids, cardiac glycosides and starch showed presence in all the 5 extracts analysed. Quinones and cardiac glycosides were weakly present in hexane extract while starch showed moderate presence. Moderate and weak presence ofterpenoids and cardiac glycosides were seen in aqueous, methanol and acetone extracts while in ethyl acetate and hexane these metabolites could not be detected.Suvarna*et al.*(2014)reported the presence of flavonoids, saponins, terpenoids etc indifferent organic solvent extracts of *Artocarpushirsutus* edible fruit part. Aqueous extract of unripe fruits showed strong intensity of aminoacids,

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 6, 2021, Pages. 7263 - 7272
Received 25 April 2021; Accepted 08 May 2021.

flavonoids, gums and mucilages, resins, phenols and cardiac glycosides while tannins and saponins were moderately present. Proteins and reducing sugars could not be traced in aqueous extract of the fruit sample.

Steroids showed weak presence in all the extracts of unripe fruit. Strong presence of amino acids was also noted in the methanolicextract of fruits. Moderate and weak presence of aminoacids were exhibited by ethyl acetate and acetone fraction of fruits. Hexane extract of unripe fruits did not showed the presence of aminoacids (Table 1).

Mohanty and Pradhan (2014) screened the petroleum ether, methanol and ethyl acetate extracts of breadfruit and reported the presence of steroids, phenols and flavonoids in methanolic fraction of fruit.In the present investigation proteins exhibited high intensity in the acetone and methanolicunripe fruit extracts, followed by weak intensity in ethyl acetate fraction however this biomolecule could not be traced in the aqueous and hexane extracts.Golden and Williams (2001) identified an increase in the amino acid, carbohydrate and fatty acid content of *Artocarpusaltilis*when the unripe green fruits changed to yellow ripe ones. Reducing sugars could not be detected in hexane extracts of unripe fruits, but it showed weak presence in ethyl acetate extract, moderate presence in acetone extract and strong presence in methanol extract(Table 1).

Flavonoid screening in the ethyl acetate and hexane unripe fruit extract failed toshowits presence, while in the acetone and methanol extracts its weak presence was observed. Aqueous extract of unripe fruits showed strong occurrence of flavonoids (Table 1). Gums and mucilage could not be detected in the hexane extract and ethyl acetate extract of unripe fruits and its weak presence was noted in acetone extract of fruit while methanol fraction of unripe fruits was found to possess high level of gums and mucilage (Table 1). Phytocompounds like phenols and tannins was seen in high intensity in the methanol extract of unripe fruits, while, ethyl acetate, hexane and acetone extracts these phytocompounds could not be detected.

Resins were strongly detected in acetone and methanol extract of unripe fruits while it was weakly found in aqueous extract. Ethyl acetate and hexane fractions reported complete absence of resins.The most important factor to be highlighted is the strong presence of terpenoids in all the 5 fruit extracts. Cardiac glycosides were strongly detected in all the fruit extracts except hexane which exhibited its weak presence.

Volatile oil was also strongly present in the ethyl acetate, acetone and methanolic extract of

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 6, 2021, Pages. 7263 - 7272
Received 25 April 2021; Accepted 08 May 2021.

breadfruit while aqueous and hexane extracts did not showedits presence. Total absence of alkaloids and phlobatannins were reported in all the five extracts of fruit.Jiyauddin*et al*(2014) screened the methanolic extract of breadfruit for the presence of various phytochemicals and reported the presence of phenolics, flavonoids, glycosides, steroids and absence of alkaloids , tannins, and saponins. These results could be correlated with the present findings except for the absence of tannins.

Coumarins andemodols were weakly detected in the methanol extract of unripe fruits while betacyaninsseen in the acetone extract, while this compound could not be detected in the other extracts. Strong presence of anthraquinonesand fatty acids were seen in the methanolic extract of unripe fruits (Table 1).

The presence of compounds such as acids, quinones, tannins, gums and mucilages, phenols, steroids, saponins, flavonoids, terpenoids, anthraquinones, betacyanin, resins, volatile oils, cardiac glycosides, fixed oils and fats, coumarins, reducing sugar and emodols in different cold percolation solvent extracts of ripe fruits of *Artocarpusheterophyllus* were earlier reported revealing methanol as the best solvent of choice to elute maximum number of phytochemicals from their respective fruit sample belonging to *Moraceae* family.(Jaya let *et al*., 2018).Overall results of the present study also suggested methanol as the better solvent of choice among other solvents used to elute maximum phytochemicals from unripe fruit of *Artocarpusaltils*.This capability of methanol to extract maximum phytochemicals may be attributed to its amphiphilic nature. Methanol is an amphiphilic solvent with a polar water – soluble group attatched to a water – insoluble hydrocarbon chain (Primorac*et al*., 2018) . Also breadfruit might be rich in phytochemicals with better solubility in methanol than in rest four solvents used for extraction.

All the plant metabolites identified here accounts for varied medicinal properties of plants.*Artocarpus*contains rich prenylated phenolic compounds such as geranylated flavones (Badrie and Broomes, 2010).Flavonoids are effective antioxidants and show stronger anticancer activities (Salah *et al*.,1995; Del Rio *et al*.,1997; Okwu, 2004). Carbohydrate based or modified therapeutics are used extensively in cardiovascular and hematological treatments ranging from inflammatory diseases and anti -thrombotic treatments to wound healing. (Kilcoyne& Joshi, 2007).Quinones, by their antioxidant activity improve the general health conditions. Many clinically approved drugs are quinine related compounds. (Najjar*et al*., 2011). Varatharajan*et al* .(2012) proved that terpenoids increase blood flow to the brain improve memory in people with mild dementia and also used to treat

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 6, 2021, Pages. 7263 - 7272
Received 25 April 2021; Accepted 08 May 2021.

cancer and inflammatory diseases. According to many reports, glycosides lower blood pressure (Nyarko and Addy, 1990). Medicinal, pharmaceutical and agrochemical activities like antitumour, immunosuppressive, hepatoprotective, antibacterial, plant growth hormone regulator, sex hormone, antihelminthic, cytotoxic and cardiotonic activity of plant steroids were reported by Patel and Savjani (2015).Research on marketing of drugs derived from resins point to the possibility of their further medical use in the west as well as in the countries were traditional use of resins happened.(Singh *et al*., 1993). Potential usage of gum and mucilages in various pharmaceutical preparations for novel drug delivery system (NDDS) was accomplished by Reddy and Kopparam (2013). Irshad (2009) reported the antioxidant, antibacterial, antiviral, anticancer and insecticidal activity of volatile oil as well as its role in food preservation and aromatherapy. Betacyanins possess antioxidant properties beneficial in the prevention of cancer and cardiovascular diseases (Leong *et al*., 2017). Similarly, inhibition of cancer growth through induction of apoptosis by anthraquinones was reported by Khan(2019). Unsaturated fatty acids with potential therapeutic activities were identified in *Artocarpusaltilis*oil by Aremu*et al*. (2017). Breadfruit also includes Artocarpins, phenolic compounds and lectins associated with anti- inflammatory activity (Watson and Preedy, 2009). Reports indicated that a high percentage of breadfruit carbohydrate was present mostly in the form of starch. Powdery form of breadfruit starch could be used as an exo-disintegrant in paracetamol tablet formulation at 5% w/v concentration (Ross, 2009).

TABLE 1: PHYTOCHEMICAL ANALYSIS OF UNRIPE FRUIT EXTRACTS OF *ARTOCARPUS ALTILIS* (PARKINSON) FOSBERG

S.No.	Compounds	Aqueous	Ethyl Acetate	Hexane	Acetone	Methanol
1.	Carbohydrates	+++	+++	+++	+++	+++
2.	Quinones	+++	+++	+	+++	+++
3.	Alkaloids	-	-	-	-	-
4.	Aminoacids	+++	++	-	+	+++
5.	Proteins	-	+	-	+++	+++
6.	Reducing sugars	-	+	-	++	+++
7.	Flavonoids	+++	-	-	+	+
8.	Gums &Mucilages	+++	-	-	+	+++
9.	Tannins	++	-	-	-	+++
10.	Resins	+++	-	-	+++	+++
11.	Terpenoids	+++	+++	+++	+++	+++
12.	Phenols	+++	-	-	-	+++

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 6, 2021, Pages. 7263 - 7272
Received 25 April 2021; Accepted 08 May 2021.

13.	**Saponins**	++	-	-	-	-
14.	**Cardiac glycosides**	+++	+++	+	+++	+++
15.	**Volatile oils**	-	+++	-	+++	+++
16.	**Starch**	++++	+++	++	+++	+++
17.	**Betacyanins**	-	-	-	+	-
18.	**Coumarins**	-	-	-	-	+
19.	**Steroids**	+	+	+	+	+
20.	**Anthroquinones**	-	-	-	-	+++
21.	**Phlobatannins**	-	-	-	-	-
22.	**Emodols**	-	-	-	-	+
23.	**Fatty acids**	-	-	-	-	+++

++++

abundantly present; +++strongly present; ++ moderately present; + weakly present; -absent

3 CONCLUSION

Several research works had been conducted on *Artocarpusaltilis*inorder to reveal its phytochemical properties by many researchers from different parts of the world. The present work represents an elaborate comparative phytochemical screening of mature unripe fruit of *Artocarpusaltilis.*The investigation revealed that unripe fruits of *Artocarpusaltilis* is a good source of phytoconstituents. Present phytochemical findings are in agreement with many of the reported literatures in the *Moraceae* family.Separation and purification of important metabolites and subsequent structural studies will open the way for obtaining active compounds from this plant and therefore provides scope for scientific studies in future to fight with emerging diseases. Moreover the position of this fruit (both unripe and ripe) in the culinary dishes of Asia holds more importance in the time of many pandemics in the past and in the present (in the age of Covid 19). With its easy accessibility to the commoner, this fruit is going to be a food for all in the near future as food and may be break through medicines.

REFERENCES

1. Akanbi, T.O., Nazamid, S. and Adebowale, A.A. 2009. Functional and pasting properties of a tropical breadfruit(*Artocarpusaltilis*) starch from Ile-Ife, Osun State, Nigeria, *International Food Research Journal* 16: 151-157
2. Ayoola, G.A., Coker, H.A.B., Adesegun, S.A., Adepoju-Bello, A.A., Obaweya, K., Ezennia, E.C and Atangbayila, T.O. 2008. Phytochemical screening and antioxidant

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 6, 2021, Pages. 7263 - 7272
Received 25 April 2021; Accepted 08 May 2021.

activities of some selected medicinal plants used for malaria therapy in South Western Nigeria, Trop. *J. Pharm.* Res, 7 : 1019-1024 .

3. Brain, K.R and Turner, T.D. 1975. The practical evaluation of phytopharmaceuticals, 2nd edition. Bristol :*Wright Science technica*., pp. 81-82 .
4. Pradhan, C., Mohanty, M and Rout, A.2012. Phytochemical screening and comparative bioefficacy assessment of *Artocarpusaltilis* leaf extracts for antimicrobial activity . *Frontiers in Life Science*, . Vol. 6, Nos. 3-4, 71-76 .
5. ChinmayPradhan., MonalisaMohanty., Abhijeeta Rout., AnanthBandhu., Kunja Bihari Satapathy and Hemanta Kumar Patra.2013.Phytoconstituent screening and comparative assessment of antimicrobial potentiality of *Artocarpusaltilis* fruit extracts .*International Journal of Pharmacy and Pharmaceutical Sciences* . Vol 5, Issue 3. ISSN 0975-1491 .
6. MonalisaMohanty andChinmay Pradhan.2014.Phytoconstituent Analysis and Comparative Bioefficacy Assessment of Breadfruit Leaf and Fruit Extracts for Antipathogenic Potentiality. *American Journal of Phytomedicine and Clinical Therapeutics*, vol. 2, no.1, pp. 077-087.
7. Evans, W.C.1996.*Trease and Evans Pharmacognosy* . 14th Ed. London : WB Saunders Ltd; pp. 119-159 .
8. Evans, W.C.1997. *Trease and Evans Pharmacolgy.* 14thedn. Harcourt Brace and company. Asia. Pvt. Ltd. Singapore .
9. Golden, K. D and Williams,O**.** 2001. Amino acid, fatty acid and carbohydrate content of *Artocarpusaltils*(Breadfruit), *Journal of Chromatographic Science*, vol.39, no. 6, pp. 243-250.
10. Harbone, J. B.1984. Phytochemical Methods : *A Guide to Modern Technique of Plant Analysis*, 2nd ed.
11. Harbone, J. B. 1973. Phytochemical methods : *A guide to modern techniques of plant analysis* .Chapman and Hall Ltd, London; Pp. 279 .
12. Jagtap,U.B and Bapat,V.2010 *Artocarpus* : A review of its traditional uses, phytochemistry and pharmacology . *Journal ofEthnopharmacology* ; 12 (9) : 143 – 144
13. Jiyauddin,K., Zulhabri, O., Aishah, U. A. M., Rasha, S., Hamid, K., Qamar,M.,Budiasih, S., Jawad, A.,Samer, A. D., Kaleemullah, M.,Ransy, M. R., Gamal, O. E., Eddy, Y., Fadli, A and Junaunah,. A. H. 2014. Evaluation of Antioxidant and Antimicrobial Activity of *Artocarpusaltilis* against Human Pathogens . *UK Journal of Pharmaceutical and Biosciences*, Vol. 2(4), 10-14, .

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 6, 2021, Pages. 7263 - 7272
Received 25 April 2021; Accepted 08 May 2021.

14. Kokate, C. K. 1994. *Practical pharmacognosy*(VallabhPrakashan, New Delhi), 1: 15-30 .
15. Kumar, A., Ilavarasan, R., Jayachandran, T., Decaraman, M., Aravindhan, P., Padmanaban, N and Krishnan, M.R.V. 2009 . Phytochemical investigation on a tropical plant, *Pak. J. Nutri*, 8 : 83-85 .
16. Lewis, K and Ausubel, F.M.2006 . Prospects of plant derived antibacterials . *Nat. Biotechnol.* 24, 1504-1507 .
17. Mace Gorbach, S.L.1963 .Anaerobic bacteriology for clinical laboratories . *Pharmacognosy*, 23 : 89-91 .
18. MonalisaMohanty andChinmay Pradhan .2014 .Phytoconstituent Analysis and Comparative Bioefficacy Assessment of Breadfruit Leaf and Fruit Extracts for Antipathogenic Potentiality . *American Journal of Phytomedicine and Clinical Therapeutics* . ISSN 2321-2748,
19. MonalisaMohanty andChinmay Pradhan.2015. A Review on Phytochemistry, Bio-Efficacy, Medicinal and Ethno-Pharmaceutical Importance of *Artocarpusaltilis* .*Human Journals*, Vol:3, Issue:1,
20. Julia F. Morton**.**1987. *In : Fruits of warm climates, Florida* Flair Books, *Miami*, pp. 50-58.
21. Justesen, U and Knuthsen, P. 2001. Composition of flavonoids in fresh herbs and calculation of flavonoid intake by use of herbs in traditional Danish dishes,*Food Chem,*vol.73, pp. 245-250 .
22. Naira Nayeem *et al.*2013.*Artocarpusaltilis*: Over View of a Plant which is referred to as Breadfruit.*International Journal of Pharmaceutical Sciences Letters*; 3 (5) : 1-3 .
23. Orwaet *etal*. *Artocarpusaltilis*. 2014 [Online] Available from: agroforestry.net/tti/A.altilis-breadfruit.pdf
24. Sivagnanasundaram, P and Karunanayake, K. O. L. C. 2015. Phytochemical Screening and Antimicrobial Activity of *Artocarpusaltilis*Leaf and Stem Bark Extracts. *OUSL Journal* , Vol. 9, pp. 1-17.
25. Raaman, N.2006 .Phytochemical Methods, New Indian Publishing Agencies, New Delhi, p. 19 .
26. Raaman, N., Sivaraj, C and Tenzing.2014. Antioxidant Activities and Phytochemical Analysis of Methanol Extract of Leaves of *Artocarpusheterophyllus* Lam . *International Journal of Pharmacy&Pharmaceutical Sciences;*, Vol. 6 Issue 8, p: 289 .

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 6, 2021, Pages. 7263 - 7272
Received 25 April 2021; Accepted 08 May 2021.

27. Ragone, D. 2006 .*Artocarpusaltilis*(breadfruit). In : C.R. Elevitch (Ed.),Species Profiles for Pacific Island Agroforestry, Version 2.1. *Permanent Agriculture Resources*, Halualoa, Hawaii, pp. 1-17 .
28. Rice – Evans, C.A and Packer, L.1998.*Flavonoids in Health and Disease*, 2nd ed.; Marcel Dekker Inc. : New York, NY, USA, .
29. Sofowara, A. 1984. Medicinal Plants and traditional medicines in Africa, *Spectrum Book Ltd*, Ibadan, Nigeria, p. 289 .
30. Sofowora, A. 1993. Medicinal Plants and Traditional Medicinal in Africa. 2nd Ed. Sunshine House, Ibadan, Nigeria. Spectrum BooksLtd; *Screening Plants for Bioactive Agents*; pp. 134-156 .
31. Somchit, M.N., Reezal, I.,Nur, I.E and Mutalib, A.R.. 2003. In vitro Antimicrobial Activity of Ethanol and Water Extracts of *Cassia alata. J. Ethanopharmacol*, 84, 1-4 .
32. Starmans, DAJ & Nijhuis, HH. Extraction of secondary metabolites from plant material: a review. *Trends in Food Science and Technology*. 1996; (7): 191-197.
33. Tiwari Kumar, B, Kaur, M, Kaur, G and Kaur, H. 2011 .*Int.Pharm Science*, , 1 : 98-106 .
34. Trease, G.E and Evans, M.D. 1989.*ATextbook of Pharmacognosy* .Builler Tindall and Caussel London , 13thedn, pp. 176-180 .
35. Vasugi Raman., Sudhahar, D and Anandarajagopal, K. 2012. Preliminary phytochemical investigation and screening of antimicrobial activity of leaf extracts of *Artocarpusaltilis* . *Asian Journal of Biological and Life Sciences* , vol. 1, Issue 2, pp.104-10
36. Vinay Suvarna, M N., Venkatachalapathy, R., MakariHanumanthappa, K and Ramesh, B S.2014. Phytochemical Analysis and Antimicrobial Activity of *Artocarpushirsutus* : An In Vitro Study . *International Journal of Pharma and Bio Sciences*; 5(3) : (P) 98 – 104 .
37. Whistler, R.L and Bemille,r J N. 1993.*Industrial Gums : Polysaccharides and their derivatives*, Academic press, San Diego, pp, 318-337 .
38. Yasuma, A and Ichikawa, T.2000 . A new Histochemical staining method for protein. *J. Lab. Clin. Med*; 41 (2) : 296-299 .
39. Evans W .C. 1997.*Pharmacology*, Harcourt Brace and Company, Asia, Singapore, pp. 226.
40. Trease, G. E and Evans, M .D.1989. *A Textbook of Pharmacognosy*, Builler Tindall and Caussel London , 13th edition, pp. 176-180 .

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 6, 2021, Pages. 7263 - 7272
Received 25 April 2021; Accepted 08 May 2021.

41. TomislavPrimorac., Martina Pozar., FranjoSokolic., Larisa Zoranicand TomazUrbic. 2018. A simple two dimensional model of methanol, *Journal of Molecular Liquids*, vol. 262, pp. 46-57.
42. Michelle Kilcoyne and Lokesh Joshi. 2007. Carbohydrates in therapeutics, cardiovasc*Hematol Agents Med chem*, vol. 5, no. 3, pp. 186-197.
43. NeelaBadrie and Jacklyn Broomes. 2010.Beneficial uses of Breadfruit (*Artocarpusaltilis*): Nutritional, Medicinal and other uses, *Bioactive Foods in Promoting Health*,pp. 491-505.
44. Patel and Savjani**.** 2015. Systematic review of plant steroids as potential anti- inflammatory agents: current status and future perspectives, *The journal of Phytopharmacology*, vol. 4, no.2, pp. 121-125
45. Ravindrakullai Reddy, M and KopparamManjunath. 2013. Pharmaceutical applications of natural gums, mucilages and pectin – A review, *International Journal of Pharmaceutical and Chemical Sciences, ISSN : 2277-5005.*
46. Varadharajan, V, Janarthanam, U K and Vijayalakshmi, K M. 2012. Physicochemical, phytochemical screening and profiling of secondary metabolites of Annona Squomosa leaf extract, *World Journal of Pharmaceutical Research*. vol.1, no.4, pp.1143-1164.
47. Ronald Ross Watson., Victor, K and Preedy .2009. *Action of individual fruits in disease and cancer, Prevention and treatment*, pg;501.
48. Anila Jaya Let, J., Beena Lawrence and Michael Babu M. 2018. Phytochemical Investigation of *Artocarpusheterophyllus* fruits. *International Journal of Engineering, Science and Computing*, vol.8, no.11, pp.18721-18275.
49. Aremu, M.O., Haruna, A., Oko, O.J and Ortutu, S.C**.** 2017.Fatty Acid, Phospholipid and Sterol Compositions of Breadfruit (*Artocarpusaltilis*) and Wonderful Kola (Buchholziaaoriaceae) Seeds, *International Journal of Sciences*, vol.6, issue. 4, pp. 116-123
50. Hui Yi Leong., Pau Lok Show., MiangHoong Lim., Chein Wei Ooi& Tau Chaun Ling. 2018. Natural Red Pigments from Plants and their health benefits :A review, *Food Reviews International Journal*, vol. 34, issue 5, pp. 463-482.
51. Ronald Ross Watson., Victor, K and Preedy .2009. *Action of individual fruits in disease and cancer, Prevention and treatment*, pg;501.
52. Nida Tabassum Khan. 2019. ANTHRAQUINONES - A Naturopathic compound, *Journal of New Develpoements in Chemistry*, vol. 2, no. 2, pp. 25-28.
53. Balakumar, S., Rajan, S., Thirunalasundari, T and Jeeva, S.2011.Antifungal ativity of Aegle

Marmelos {L} Correa {Rutaceae} leaf extracts on dermatophytes, *Asian Pacific Journal of Biomedicine*, vol.1, no.4, pp.309-312.

54. Florence, A.R., Joselin, J and Jeeva, S. 2012. Intraspecific variation of bioactive principles in selected members of the genus *Clerodendrum* L. *Journal of Chemical and Pharmaceutical Research*, vol. 4, no.11, pp. 4908 – 4914.

55. Addy, M.E and Nyarko, A.A.1990. Effects of aqueous extracts of *Adenia cissampeloides* on blood pressure and serum analyte of hypertensive patients, *Phytotherapy Research*, vol.4, no.1, pp.25-28.

56. **Okwu, D.E and Josiah, C.**2006. Evaluation of the chemical composition of two Nigerian medicinal plants, *African Journal of Biotechnology*, vol.5, no. 4,**pp.357 – 361.**

57. **Okwu, D. E.** 2001. Evaluation of the chemical composition of indigeneous species and flavouring agents, *Global Journal of Pure and Applied Sciences*, vol. seven, no.3, pp.455-459.

58. **Salah, N., Miller, N.J., Pagange, G., Tijburg, L., Bolwell, G. P., Rice, E and Evans, C.**1995.Polyphenolic flavonoids as scavenger of aqueous phase radicals as chain breaking antioxidant, *Archives of Biochemistry and Biophysics*, vol.322, no.2, pp.33nine- 346.

59. **Del –Rio, A., Obdululio, B. G., Casfillo, J., Main , F. G and Ortuno, A.**1997, Uses and properties of Citrus flavonoids, *Journal of Agriculture and Food Chemistry*, vol.45, no.12, pp.4505-4515.

60. **Lee Yit Leong., Nuramira binti Nadzri., Khor Chu Yee., Norawanis binti Abdul Razak and Abdul Razak Shaari**. 2018.Antioxidant and Total Phenlic Content of Breadfruit (*Artocarpus altilis*) Leaves. *MATECWeb of Conferences* 150, 06007, pp.1-4.

ACKNOWLEDGEMENT

We acknowledge the help extended by each and everyone during the entire period of this research work